Rules for the Classification of Air Cushion Vehicles

January 2019

Lloyd's Register

A guide to the Rules

and published requirements

Rules for the Classification of Air Cushion Vehicles

Introduction

The Rules are published as a complete set.

Rules updating

The Rules are published periodically and changed through a system of Notices between releases.

July 2019

Section 1
General

1.1 Rule application

1.1.1 Amphibious Air Cushion Vehicles (hereinafter referred to as ACVs) are considered upon request in accordance with *Pt 1, Ch 2, 2.1 Applicable craft types 2.1.2* of the *Rules and Regulations for the Classification of Special Service Craft* (hereinafter referred to as SSC Rules). In addition to the following requirements, ACVs are to comply with the General Regulations given in *Pt 1 Regulations* of the SSC Rules.

1.1.2 These Rules contain requirements for ACVs of aluminium construction and fitted with flexible skirts. ACVs are defined in *Pt 1, Ch 2, 2.2 Definitions* of the SSC Rules.

1.1.3 Where the requirements given in these Rules are complied with, an appropriate notation may be assigned, *see Pt 1, Ch 2, 3.7 Craft type notations* and *Pt 1, Ch 2 Classification Regulations* of the SSC Rules.

1.1.4 Where any aspect of the design or construction is not covered by this Rule set, the relevant requirements of other parts of the SSC Rules are to be applied as appropriate.

1.1.5 Alternative methods of establishing design criteria will be specially considered, provided they are based on established Codes or Standards acceptable to Lloyd's Register (hereinafter referred to as LR).

1.1.6 ACVs built and classed in accordance with these Rules will be assigned an operational envelope. This will be based on the allowable speeds, maximum wave height and corresponding all-up weight. It will form an appendix to the Classification Certificate and is to be incorporated into the ACVs' Operational Manual. The assigned operational envelope is to be clearly displayed in the wheelhouse.

1.1.7 Impact, on the hard structure or other components, other than wave impact, during operation is outside the scope of Classification.

1.2 Definitions and symbols

1.2.1 The following definitions apply except where they are inappropriate or where specifically defined otherwise.

1.2.2 **Hard structure,** is the watertight hull envelope excluding any skirt systems.

1.2.3 **Maximum All-Up-Weight, W_{max},** is the maximum weight at which the ACV has been assessed for normal operation, in kg.

1.2.4 **Minimum All-Up-Weight, W_{min}** , is the minimum weight at which the ACV has been assessed for normal operation, in kg.

1.2.5 **Lifting Weight, W_L** , is the maximum weight at which the ACV has been assessed for jacking and slinging, in kg.

1.2.6 **Length, L,** is the maximum length of the hard structure, excluding projections, in metres.

1.2.7 **Length overall, L_{OA}** , is the maximum overall length of the ACV, in metres.

1.2.8 **Breadth, B** , is the maximum breadth of the hard structure excluding projections, in metres.

1.2.9 **Breadth overall, B_{OA}** , is the maximum overall breadth of the ACV, in metres.

1.2.10 **Depth, D** , is the maximum depth of the hard structure, in metres.

1.2.11 **Draught, T**, is the off-cushion draught at the design waterline, in metres.

1.2.12 **LCG** is the longitudinal centre of gravity, in metres.

Section 2
Materials Requirements

2.1 Materials

2.1.1 The materials used in the construction of the ACV are to be manufactured and tested in accordance with the requirements of the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials).

2.1.2 Material specifications are to be clearly indicated on the construction drawings. For design purposes, properties of aluminium alloys are to be taken for the welded condition. The minimum strength properties of aluminium alloys approved for structural use are given in *Ch 13, 8.3 Fabrication and welding 8.3.2* of the Rules for Materials.

2.1.3 Where bimetallic connections are made, involving dissimilar metals, measures are to be incorporated to prevent galvanic corrosion. The design is to ensure that the location of all bimetallic connections allows for regular inspection and maintenance of the joints during service.

2.1.4 Further requirements for aluminium alloy construction are given in *Pt 7, Ch 2 Construction Procedures* of the SSC Rules. ACVs constructed of materials other than aluminium will be specially considered.

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Section 1
Hull survey requirements during construction

1.1 Introduction

1.1.1 The requirements of SSC Rules *Pt 1 Regulations* are applicable.

Section 2
Machinery survey requirements during construction

2.1 Introduction

2.1.1 The requirements of SSC Rules *Pt 9, Ch 2 Surveys During Construction, Installation and Sea Trials*, are applicable together with the additional requirements of this Section.

2.1.2 New ACVs intended for Classification are to be built under LR Survey. Any items found not to be in accordance with the Rules or the appraised plans, or any material, workmanship or arrangements found so to be, are to be rectified or concession sought from LR.

2.2 Propellers (airscrew) and lift fans

2.2.1 The propeller and lift fan equipment is to be subject to an initial survey, and periodic surveys. This shall be addressed in accordance with approved maintenance manuals and schedules, and the equipment shown is to be to the attending Surveyor's satisfaction.

2.2.2 LR is to be provided with copies of relevant certificates and evidence of continuing to maintain certification under EASA Part 21 and Part 145 approvals as applicable to the organisation. LR will conduct an initial visit and periodic visits in accordance with a certification schedule agreed with LR in order to verify compliance.

2.3 Fuel storage and delivery

2.3.1 Each installation is to be surveyed and tested by the Surveyor in accordance with the approved plans.

2.4 Steering arrangements

2.4.1 Where the secondary means of steering is by means of a skirt shift system, the system is to be surveyed at the construction yard and demonstrated during trials.

2.5 Sea trials

2.5.1 Trials schedules are to be drawn up and submitted to LR for consideration.

2.5.2 The Performance Trial is to include sufficient continuous operation at main engine MCR to demonstrate satisfactory performance of the ACV.

2.5.3 Sea trials are to include the operation of any anchoring equipment including deployment and recovery.

2.5.4 The results of the trials are to be reported to LR.

2.6 Prototype vehicle trials

2.6.1 Trials are to be conducted on all prototype ACV to show or determine:

(a) That the assumptions made as regard to the weights and centres of gravity of the ACV as a whole and its major components (hull, machinery, loads, etc.) are reasonably correct.

(b) That the stability and control of the ACV can be effectively maintained in all accepted conditions of weather and loading.
(c) That the accepted conditions of operation are within the safe limits of all operating parameters.
(d) That there is no undue vibration in the hull structure or machinery.
(e) That, on completion of all other tests and trials, all controls and systems relating to the operation, safety and reliability of the ACV are functioning satisfactorily.

2.6.2 In particular, the trials schedules for prototype vehicles are to include the following:

(a) An endurance trial of agreed length at main engine MCR.
(b) Emergency crash stop procedure.
(c) Slow and fast turning to port and starboard.
(d) Taxiing and manoeuvring waterborne (and on land if amphibious).
(e) Where applicable, moving on and off a typical landing site under representative conditions (amphibious craft).
(f) Simulated engine failure, single or multi-engine designs.
(g) Anchoring arrangements are to be verified (required if the classification notation '**1**' is required).
(h) With battery starting, a minimum of six consecutive engine starts under operational conditions, with due precautions against overheating of starting equipment.
(i) Bilge and/or dewatering pumping and vehicle trimming systems under operating conditions.
(j) Simulated use of protective, fire-fighting, life-saving and other safety equipment.
(k) Examination of gearing after trials, so far as is practicable.

2.7 Production line vehicle trials

2.7.1 Trials are to be conducted on all vehicles made subsequent to, but to the same plans and details as, a previously classed prototype ACV. In general, routine production ACV need not be subjected to such extensive trials as those required for prototype vehicles, but shall in any case demonstrate:

(a) That all controls and systems relating to the operation, safety and reliability of the ACV are functioning satisfactorily.
(b) That any modifications from the prototype, or alterations in the operation and maintenance instructions given in the Operator's Handbooks, are practicable and reasonable.

2.8 Trials after modification, overhaul or repairs

2.8.1 Trials are to be made on ACV which have been significantly modified, overhauled or repaired to ensure to the Surveyors' satisfaction that the vehicle has been returned in a satisfactory condition for its intended service.

Contents

Section 1
Plans and particulars

1.1 Plans and particulars to be submitted

1.1.1 The following plans and particulars are to be submitted for appraisal, where applicable:

(a) General arrangement of ACV and principal particulars.
(b) Weights and centres of gravity of the hull, consumables, stores and payload.
(c) Design performance parameters (gross displacement mass vs. speed vs. wave height).
(d) Load-carrying platforms and decks.
(e) Main longitudinal girders and beams.
(f) Main transverse and diagonal girders, frames and beams.
(g) Watertight bulkheads and integral buoyancy tanks.
(h) Integral fuel and water tanks.
(i) Bottom and side shell plating.
(j) Webs or other arrangements to resist impact loads.
(k) Machinery foundations.
(l) Duct openings and framing.
(m) Side bodies.
(n) Superstructure and deck-house.
(o) Closing arrangements.
(p) Air rudders and propeller ducts.
(q) General arrangement and attachments of propeller ducts, pylons and air propellers.
(r) Lift fan inlet and outlet arrangements.
(s) General arrangement and attachments of skirts.
(t) General arrangements and attachments of external fuel and water tanks.
(u) Vehicle and cargo decks (including tie-down fittings).
(v) Crane foundation.
(w) Loading ramp.
(x) Anchoring and mooring equipment.
(y) Welding details.

All plans are to be presented in a clear and unambiguous manner with sufficient detail to avoid misinterpretation.

1.2 Requirements for supporting calculations

1.2.1 Scantlings of ACVs require special consideration and calculations are to be submitted in support of the main structural plans and data given in *Ch 3, 1.1 Plans and particulars to be submitted*. The supporting calculations are generally to be contained in a report which is to include the following, where applicable:

(a) Lists of plans used, including dates and versions.
(b) Description of structural models, including all modelling assumptions.
(c) Plots to demonstrate correct structural modelling and assigned properties.
(d) Details of material properties used.
(e) Details of all load cases.
(f) Design criteria.
(g) Buckling analysis.
(h) Results showing compliance, or otherwise, with the design criteria.
(i) Proposed amendments to structure where necessary, including revised assessment of stresses and buckling capabilities.

1.2.2 Structural loads are to be calculated in accordance with this document. Alternatively, loads may be derived through direct calculations. All such calculations are to be submitted for examination.

1.2.3 The scantlings of structurally complicated ACVs or design aspects may require to be supplemented by detailed structural analysis using the finite element method or equivalent. These supplementary calculations are to be discussed with LR prior to submission.

1.2.4 Generally, loads and stresses are to be expressed in kN and N/mm^2 respectively. Limiting stress coefficients for bending, shear and equivalent stress are given in *Ch 3, 10 Limiting stress coefficients* for both local and global loads. However, buckling considerations may result in limiting stress coefficients lower than these values.

1.2.5 The responsibility for error-free specification and input of program data and the subsequent correct transposal of data rests with the designer.

1.3 Standard designs

1.3.1 Requirements for standard designs are given in *Pt 3, Ch 1, 5.3 Standard designs* of the SSC Rules.

Section 2
Global hull loads and strength

2.1 Calculation principle

2.1.1 In each of the global load cases for the ACV, the problem is treated as quasi-static, where the external forces applied to the ACV at any instant are balanced against the inertia forces produced by the acceleration of the ACV under those external forces.

2.1.2 The weight of the ACV is to be divided longitudinally into an appropriate number of stations, '*n*'. The weight of the ACV may be represented by a series of point loads distributed along the length and the total weight is to equal the desired operational weight. The LCG is to be determined from a weights and moments analysis.

2.1.3 The radius of gyration in pitch, *r*, of the ACV is given by:

$$r = \sqrt{\frac{I_{\mathrm{m}}}{\mathrm{W}}} \text{ in metres}$$

I_{m} = mass moment of inertia about the LCG, in kg/m^2

$$= \sum_{i=1}^{n} w_{\mathrm{i}} x^2_{\mathrm{i}}$$

2.1.4 where

W_{i} = weight at station 'i'

x_i = distance of station 'i' from LCG

W = W_{min} or W_{max}, in kg

n = number of stations.

2.2 Acceleration due to wave impact

2.2.1 In theory the ACV may receive a wave impact at any point 'i' along its length, for example at the bow, stern or LCG, and the rigid body acceleration is to be calculated for a series of impact locations along the length to give an envelope of design values. The maximum acceleration may not always occur at the maximum speed and/or wave height and therefore a range of speeds and wave heights is to be investigated to determine the design values.

2.2.2 The vertical acceleration at the LCG, $a_{v,i}$, for the location 'i' to be examined for wave impact in terms of g is given by:

$$a_{v,i} = \frac{0,52K_1V_V V}{W^{1/3}\left(1+r_x^2\right)^{2/3}}$$ where $a_{v,i}$ is not to be taken less than 0,5

where

K_1 = hull station load distribution factor and is to be taken as:

K_1 = 1,0 between stern and x_{LCG}

= 1,5 at bow

intermediate values are to be determined by linear interpolation

V_V = relative vertical velocity in m/s

$$V_v = \frac{4H}{\sqrt{\lambda}} + 0,6$$

H = wave height, in metres

λ = wave length, in metres and is to be taken as given in *Ch 3, 2.4 Floating loads*

V = speed of ACV at wave height H in knots

r_x = ratio of distance measured parallel to the hull reference axis from the LCG of the ACV to the hull longitudinal station 'i' at the location to be examined, to the radius of gyration in pitch of the ACV:

$$r_x = \frac{d}{r}$$

d = distance between hull longitudinal station 'i' and the LCG, in metres

r = radius of gyration in pitch of the ACV as defined in *Ch 3, 2.1 Calculation principle 2.1.3*

W as defined in *Ch 3, 2.1 Calculation principle 2.1.3*.

2.2.3 The acceleration, $a_{X,i}$, at any given station 'i' along the hull in terms of g may then be taken as:

$$a_{X,i} = a_{v,i}\left(1 + \frac{dl_a}{r^2}\right)$$

where

d as defined in *Ch 3, 2.2 Acceleration due to wave impact 2.2.2*

l_a = distance of point at which acceleration is required from the LCG, in metres

r = radius of gyration in pitch of the ACV, in metres.

2.2.4 For a wave impact occurring at the LCG, the vertical acceleration is constant along the length of the ACV. Wave impacts occurring away from the LCG will give rise to angular accelerations.

2.3 Structural response to wave impact

2.3.1 The vertical load acting at each station as a result of the ACV acceleration is the product of the weight, w_i, and the acceleration, $a_{x,i}$, at that station. The total vertical load acting on the ACV is the sum of the station loads. This total vertical load is to be balanced by the wave impact force, $F_{w,i}$, at the chosen impact location and as given in *Ch 3, 2.3 Structural response to wave impact 2.3.2*. For this equilibrium condition the shear force and bending moment distribution for the overall hull length can now be calculated. In general, the vertical loads acting at each station and wave impact force are to be applied as point loads and it is recommended that the wave impact load be taken as negative. An example wave impact force balance diagram force can be seen in *Figure 3.2.1 Example wave impact force balance diagram*.

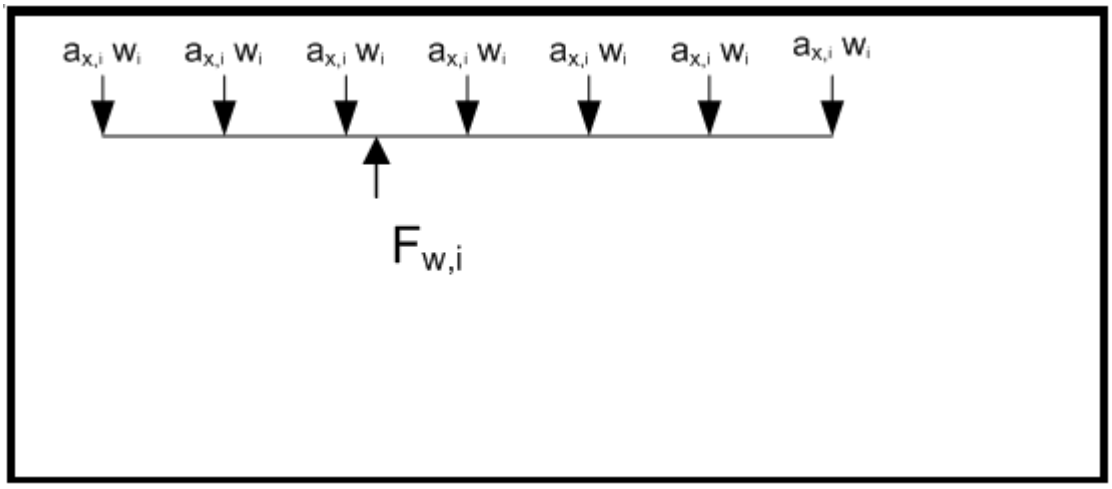

Figure 3.2.1 Example wave impact force balance diagram

2.3.2 Wave impact load is to be taken as:

$$F_{w,i} = a_{v,i} \cdot W \cdot \frac{g}{1000} \text{ kN}$$

where

$a_{v,i}$ is defined in *Ch 3, 2.2 Acceleration due to wave impact 2.2.2*.

W is defined in *Ch 3, 2.1 Calculation principle 2.1.3*.

g is the acceleration due to gravity (9,81 m/sec^2)

2.3.3 Acceleration due to gravity is not applied to the wave impact cases as it is assumed that the pressure under the hull and the weight of the ACV are reasonably uniformly distributed and will balance out.

2.4 Floating loads

2.4.1 The hogging and sagging conditions are as illustrated in *Figure 3.2.2 Sagging and Hogging Waves*. A range of wave lengths and wave heights are to be investigated to give the worst loading case and the ACV is to be supported on a trochoidal wave(s) of all lengths that are likely to be critical for the intended wave heights. As a minimum, hogging and sagging wave cases are to be investigated with the trough at midship and crests at the bow and the stern. For the purposes of this calculation the ACV may not necessarily be immersed at all stations.

2.4.2 The wave length to wave height ratio is to be 10:1 for wave lengths not exceeding 36,9 m. Where the wave length exceeds 36,9 m, the wave height is to be taken as $0,607\sqrt{\lambda}$.

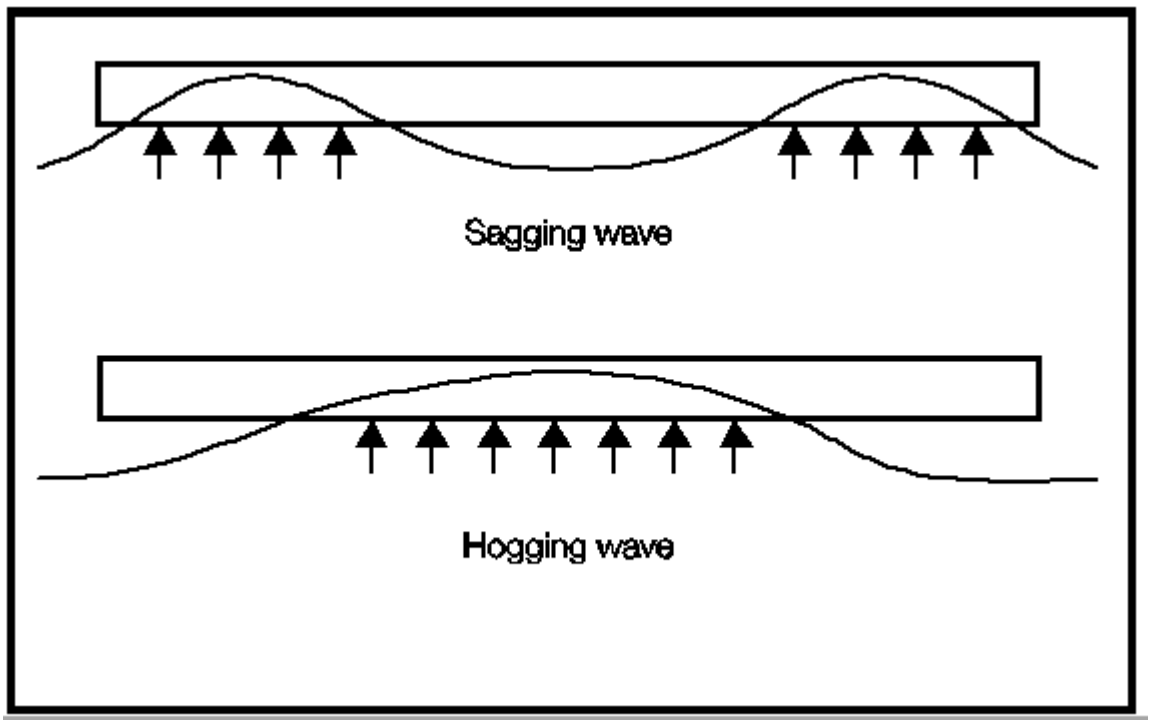

Figure 3.2.2 Sagging and Hogging Waves

2.5 Slinging and jacking loads

2.5.1 Global longitudinal and transverse strength is to be investigated for slinging and jacking loads. Allowance is to be made for any variation of the centre of gravity.

2.5.2 The maximum lifting weight and weight distribution are to be stated in the Operational Manual.

2.6 Parking loads

2.6.1 Global longitudinal and transverse strength is to be investigated for parking loads. The craft is to be designed to support the maximum all-up weight on three-quarters of the supports and other assumed worst cases depending on the positions of the landing pads or skids.

2.7 Global strength

2.7.1 The effective sectional area of continuous longitudinal and transverse strength members, after deduction of openings, is to be used for the calculation of the section modulus.

2.7.2 In general, superstructures or deck-houses will not be accepted as contributing to the global longitudinal or transverse strength of the ACV. However, where it is proposed to include substantial continuous stiffening members, special consideration will be given to their inclusion.

2.7.3 The contribution of riveted components will be specially considered.

2.7.4 Structural members which contribute to the overall hull girder strength are to be carefully aligned so as to avoid discontinuities resulting in abrupt variations of stresses and are to be kept clear of any form of opening which may affect their structural performance.

2.7.5 For all structural members that contribute to the hull girder strength, buckling strength is to be adequate to withstand in-plane compressive, bending and shear loads. Generally, the shear loads are assumed to be carried through vertical divisions.

Section 3
Local hull loads and strength

3.1 Impact loads on the bottom and side shell

3.1.1 The peak pressure at any point along the length of the bottom structure is given by:

$$p_{peak} = 0{,}62K_2 V_v V \text{ kN/m}^2$$

where

$$K_2 = \frac{4x}{L} - 2 \text{ for } x/L > 0{,}75$$

$$K_2 = 1{,}0 \text{ for } x/L \leq 0{,}75$$

x = distance from aft end to the point at which K_2 is required, in metres

V, V_v as defined in *Ch 3, 2.2 Acceleration due to wave impact 2.2.2*

L is defined in *Ch 1, 1.2 Definitions and symbols*.

3.1.2 The distributed pressure, p_{dist}, along the length of the bottom structure is taken as 0,44 times the local pressure.

3.1.3 The peak pressure, p_{peak}, is generally to be applied to plating and secondary stiffeners. The distributed pressure is generally to be applied to primary frames, girders and large unstiffened panels of plating.

3.1.4 Both the peak pressure and distributed pressure are to be applied to the bottom structure to the transverse extent of the outermost chine. Above this point both pressures may be reduced linearly to pressure, p_{gun}, at the gunwale.

$$p_{gun} = K_3(5 + 0{,}01L)\left(1 + 0{,}5a_{v,i}\right) + 3 \text{ kN/m}^2$$

where

$$K_3 = \frac{2x}{L} - 0{,}5 \text{ for } x/L > 0{,}75$$

$$K_3 = 1{,}0 \text{ for } x/L \leq 0{,}75$$

x = distance from aft end to the point at which K_3 is required, in metres

L is defined in *Ch 1, 1.2 Definitions and symbols*

$a_{v,i}$ is defined in *Ch 3, 2.2 Acceleration due to wave impact 2.2.2* for the longitudinal centre of gravity impact case and is not to be taken less than 1,0.

3.2 Floating loads

3.2.1 In addition to the loads given in *Ch 3, 3.1 Impact loads on the bottom and side shell*, local loads acting on the bottom and side shell when the ACV is off-cushion and floating whilst underway at the maximum towing speed will be specially considered in accordance with *Pt 5, Ch 4, 3 Hull envelope design criteria* of the SSC Rules.

3.3 Deck loads

3.3.1 Local loads acting on the decks are to be specially considered in accordance with the requirements of *Pt 5, Ch 4 Local Design Criteria for Craft Operating in Displacement Mode* of the SSC Rules.

3.4 Machinery loads

3.4.1 Machinery foundation reactions resulting from collision accelerations, torque and dynamic loads are to be provided by the designer.

3.4.2 The loadings mentioned in *Ch 3, 3.4 Machinery loads 3.4.1* are to be used additionally to assess the attachment of resilient mounts where fitted.

3.5 Slinging and jacking loads

3.5.1 The supporting structure, such as lifting posts and struts, is to be designed to carry the slinging and jacking loads at each lifting point and is to have adequate buckling capacity to withstand the concentrated loads. Allowance is to be made for the inclination of any lifting wires which may give rise to longitudinal, transverse and vertical loads.

3.6 Collision loads

3.6.1 The strength of supporting structure and attachments of masses greater than 50 kg are to be able to withstand the following accelerations without fracturing or suffering permanent deformation:

- 6g forward direction.
- 3g after direction.
- 3g transverse direction.
- 3g vertical direction.

3.7 Local strength

3.7.1 When applying the loads given in this Section the requirements for plating and stiffeners given in *Pt 7, Ch 3, 1.16 Plating general* and *Pt 7, Ch 3, 1.17 Stiffening general* of the SSC Rules are generally to be applied. Other strength models will be considered, provided they conform to recognised theory or standards and are agreed with LR.

3.7.2 Laterally loaded thin skins designed to support the design pressure by membrane action with associated large deflections will be specially considered, *see also* 2.7.5. For guidance, the thickness of thin skins, t_{skin}, may be derived as follows:

$$t_{skin} = \frac{pa}{\sqrt{\frac{\left(\frac{\sigma_a f_\sigma}{\eta}\right)^3}{E}}} \text{ mm}$$

3.7.3 where

p = design pressure, in kN/m^2

a = longest dimension of the skin, in m

b = shortest dimension of the skin, in m

σ_a = 0,2 per cent proof stress of the aluminium, in N/mm^2

f_σ = stress fraction, *see Table 3.10.1 Limiting stress coefficients for local loading*

η = $0{,}0085\alpha^2 - 0{,}1025\,\alpha + 0{,}5$

α = a/b

E = modulus of elasticity, in N/mm$_2$

3.7.4 Structural geometry is to be arranged and detailed to ensure a smooth transfer of loads throughout the structure. Concentrated or point loads are to be transmitted into the supporting structure by a series of stiff supporting members. In no case are concentrated or point loads to land on unsupported plating.

3.7.5 The longitudinal girders forming the machinery foundations are to extend as far forward and aft as practicable and be adequately supported by transverse primary structure.

3.7.6 Integration of lift fans and associated supporting structure will be specially considered.

3.7.7 In areas where fluctuating pressure (panting) occurs e.g. fan bays, inlets, volutes etc. design details will be specially considered.

3.7.8 Openings in the structure are to be suitably framed and have well-rounded corners to minimise stress concentrations.

Section 4
Superstructures and deck-houses

4.1 Design loads

4.1.1 Design loads for superstructures and deck-houses are given in *Pt 5, Ch 4, 3 Hull envelope design criteria* of the SSC Rules. Loads are to be determined assuming that the ACV is off-cushion and floating whilst underway at the maximum towing speed.

4.1.2 Design loads for machinery casings may be taken as for superstructure and deck-houses in the same position.

4.1.3 As an alternative to *Ch 3, 4.1 Design loads 4.1.1* and *Ch 3, 4.1 Design loads 4.1.2*, the designer may submit design loads for consideration. These loads may include but are not limited to the following:

(a) Concentrated loads due to equipment;
(b) Personnel loads;
(c) Snow and ice loads;
(d) Wind loads;
(e) Marine environmental loads.

4.2 Structure

4.2.1 All openings are to be substantially framed and have well-rounded corners. Arrangements are to be made to minimise the effects of discontinuities.

4.2.2 Special attention is to be given to the connection of the superstructure and deck-house to the deck in order to provide an adequate load distribution and avoid stress concentrations.

4.2.3 Where pillars are fitted to support the span of stiffening members, they are to comply with the requirements of *Pt 7, Ch 3, 10 Pillars and pillar bulkheads* of the SSC Rules.

Section 5
Hull appendages

5.1 Skirts and side bodies

5.1.1 The design and scantlings of the skirt are outside the scope of classification; however, the designers are to submit their proposals in respect of the hull attachment detail. The strength of the hull attachment is to be based on the breaking load of the straps, ties, cords or cables to which it is attached.

5.1.2 Where side bodies are fitted, their scantlings will be specially considered. The side bodies are to be designed with respect to the worst possible combinations of loads resulting from cushion pressure, personnel or other concentrated or distributed loads.

5.1.3 Suitable supporting structure is to be provided in way of hull attachments for skirts and side bodies.

5.2 Air rudders and propeller ducts

5.2.1 The scantlings of the air rudders, propeller ducts, and their support and attachments will be specially considered on request. The designer is to include details of the maximum design loads, which may include both aerodynamic and actuating loads as well as design safety factors.

5.2.2 The hull supporting structure and attachments of the ducts will also be considered for loads resulting from collision accelerations.

5.3 Air propeller supports and pylons

5.3.1 The hull supporting structure and attachments of the air propeller supports or pylons will be considered for loads resulting from collision accelerations.

5.4 Landing pads and skids

5.4.1 ACVs are to be fitted with landing pads or skids to facilitate parking. The ACV is to be designed to support the maximum all-up weight on three-quarters of the supports. The landing pads or skids are to be integrated and aligned with the hull supporting structure which is to be additionally stiffened where necessary.

Section 6
Bulkheads and subdivision

6.1 General requirements

6.1.1 The ACV is to have an intact buoyancy reserve of at least 100 per cent at the maximum operational weight.

6.1.2 The hull is generally subdivided by longitudinal girders and transverse primary members. Individual spaces formed by these intersecting members and which are required to contribute to buoyancy are to be designed as watertight structures. For structural design purposes the load head in metres is to be measured vertically, as follows:

- Plating – the distance from a point one third of the height of the plate above its lower edge to the top skin.
- Stiffening – the distance from the mid-span of stiffener to the top skin.

6.1.3 Tests are to be carried out to check the tightness and integrity of individual buoyancy spaces. Testing requirements are to be agreed with the attending Surveyor.

6.1.4 Access to the buoyancy spaces is to be provided for inspection to the satisfaction of the attending Surveyor.

Section 7
Anchoring and mooring equipment

7.1 General

7.1.1 Equipment requirements are to be as required by *Pt 3, Ch 5 Anchoring and Mooring Equipment* of the SSC Rules for mono-hull craft except as otherwise specified in this Chapter.

7.1.2 Anchor requirements are based on the use of High Holding Power (HHP) anchors. Where Super High Holding Power (SHHP) anchors are used, the mass may be reduced by 33 per cent.

7.2 Equipment Number

7.2.1 The Equipment Number, EN, is to be calculated in accordance with the requirements of *Pt 3, Ch 5, 2.1 Equipment Number 2.1.2* of the SSC Rules

7.2.2 Fenders, tail fins, air propellers, ducts and flexible skirts need not be included in the calculation of the Equipment Number.

7.3 Arrangements

7.3.1 ACVs are to be provided with a single anchor on board which must be readily available for use. Suitable storage is to be provided for the anchor cable and means of recovery are to be provided (recovery of the anchor by hand may be permitted). The bitter end of the anchor cable is to be connected to a suitable strong point on the ACV.

7.3.2 Arrangements are to be in place to prevent the anchor snagging or damaging the skirt during launching and recovery.

7.3.3 The craft in way of anchor and cable is to have suitable arrangements as to protect the structure from being damaged during normal operation.

7.3.4 The construction and attachment of anchoring equipment, towing bitts, mooring bollards, fairleads, cleats and eyebolts are to be able to withstand the breaking strength of the anchor cable, mooring lines or towlines. Breaking strength loads and any directional limitations assumed are to be shown on the submitted plans.

7.3.5 The equipment supporting structure is to be able to withstand a load of up to 1,2 times the breaking strength of the anchor cable, mooring lines or towlines. The supporting structure is to have adequate resistance to buckling and be able to facilitate efficient distribution of the load.

7.3.6 The maximum permissible speed at which the ACV may be towed is to be included in the Operational Manual.

Section 8
Closing arrangements

8.1 General

8.1.1 Weathertight closing arrangements are appliances (such as windows, doors and hatches) which, when closed, will prevent water penetration into the ACV in any wind and wave conditions up to those commensurate with the service of the ACV. Such appliances are to comply with the requirements of *Pt 3, Ch 4 Closing Arrangements and Outfit* of the SSC Rules where practicable.

8.1.2 Watertight closing arrangements are appliances (such as doors and hatches) which, when closed, will prevent the passage of water through the structure in any direction under the head of water likely to occur in the intact or damaged condition. Such appliances are to comply with the requirements of *Pt 3, Ch 4 Closing Arrangements and Outfit* of the SSC Rules where practicable.

8.1.3 Heights of sills and ventilator coamings are to be as high as practicable and acceptable to the National Administration.

8.1.4 Where provided, de-watering arrangements for enclosed wells are to be to the satisfaction of the attending Surveyor.

Section 9
Special features

9.1 Vehicles and deck cargo

9.1.1 Details of the deck loading resulting from the proposed stowage or operation of vehicles are to be supplied by the designer and shown on the submitted plans. These details are to include axle and wheel spacing, the wheel load, type of tyre and tyre print dimensions for the vehicles. The vehicle types and wheel loads for which the vehicle decks have been approved are to be included in the ACV's documentation and also clearly displayed on the deck.

9.1.2 Details of the deck loading resulting from the proposed stowage of cargo are to be supplied by the designer and shown on the submitted plans. The loads for which the cargo decks have been approved are to be included in the ACV's documentation and also clearly displayed on the deck.

9.1.3 The total deck load for each vehicle is distributed through the tyre footprints and is to be taken as:

$$w_{VDP} = W_{VD}\,(1 + a_{x,i})\ \text{kN}$$

where

W_{VD} is the weight of the vehicle specified by the designer, in kN

$a_{x,i}$ is given in *Ch 3, 2.2 Acceleration due to wave impact 2.2.3*

The cargo deck pressure is to be taken as:

$$P_{CDP} = P_{CD}\,(1 + a_{x,i})\ \text{kN/m}^2$$

where

P_{CD} is the pressure exerted by the cargo on deck specified by the designer

$a_{x,i}$ is given in *Ch 3, 2.2 Acceleration due to wave impact 2.2.3*

9.1.4 Supporting members which are subjected to local compressive and/or shear loads are to have adequate buckling strength.

9.1.5 Details of the vehicle and cargo tie-down arrangements are to be provided. The Safe Working Load (SWL) of the vehicle and cargo tie-downs are to be used to determine the strength of the tie-down attachment to the deck and the supporting structure. When considering the loads, all expected directions of operation are to be taken into account.

9.1.6 For concentrated loads, local reinforcement to distribute the load is to be fitted as necessary.

9.1.7 Further guidance on vehicle decks is contained in *Pt 7, Ch 5, 3 Vehicle decks* of the SSC Rules.

9.2 Loading doors and ramps

9.2.1 Loading doors and ramps are to be designed to withstand wave impact loads and are to be fitted so as to ensure tightness consistent with operational conditions.

9.2.2 Ramps are to be designed to withstand concentrated loads due to vehicle and other cargo operations.

9.3 Crane support arrangements

9.3.1 Requirements for crane support arrangements are given in *Pt 7, Ch 5, 2 Special features* of the SSC Rules. Testing requirements are to be in accordance with *Pt 3, Ch 1, 7 Inspection, workmanship and testing procedures* of the SSC Rules.

9.3.2 Supporting members which are subjected to local compressive and/or shear loads are to have adequate buckling strength.

Section 10
Limiting stress coefficients

10.1 Limiting stress coefficients for local loads

10.1.1 The nominal limiting stress requirements for plating and primary and secondary stiffening members subject to local loading conditions are given in terms of limiting stress coefficients, *see Table 3.10.1 Limiting stress coefficients for local loading*. The coefficients are given as a proportion of the 0,2 per cent proof stress of the material, except where stated otherwise.

10.1.2 The limiting stress coefficients for structural elements subject to global loading are given in *Table 3.10.2 Limiting stress coefficients for global loading*.

Table 3.10.1 Limiting stress coefficients for local loading

	Limiting stress coefficient		
Item	Bending f_σ	Shear f_τ	Equivalent f_e
Bottom and side structure			
Plating	0,67	—	—
Stiffening	0,67	0,39	—
Machinery foundations	0,55	0,32	0,75
Deck structure			
Plating	0,75	—	—
Stiffening	0,65	0,38	—
Superstructure and deck-house			
Plating and stiffening	0,75	0,43	—
Bulkheads			
Watertight bulkhead plating	1,0	—	—
Watertight bulkhead stiffening	0,95	0,55	1,0
Watertight bulkhead doors and hatches	0,825	0,48	0,825
Structure supporting watertight doors and hatches	0,80	0,46	—
Slinging and jacking			
Supporting structure	0,50	0,29	—
Eyeplates	0,25 (*see* Note)		
Hull appendages			
Skirt attachments	0,50 (*see* Note)		
Side bodies	0,67	0,39	—
Air rudder scantlings	0,50	0,29	—
Hull structure supporting air rudder and air propeller supports	0,67	0,39	—
Landing pads and skids	0,67	0,39	—
Special features			
Vehicle decks and ramps	0,50	0,29	0,75
Supporting structure and tie-down fittings	0,67	0,39	0,86
Crane foundations	0,70	0,40	0,75
Anchoring and mooring equipment			

Equipment attachments	0,90	0,52	—
Equipment supporting structure	1,0	0,58	—
Note Limiting stress coefficient is given as a fraction of the Ultimate Tensile Strength (UTS) of the material.			

Table 3.10.2 Limiting stress coefficients for global loading

Item	Limiting stress coefficient		
	Bending $f_{\sigma g}$	Shear $f_{\tau g}$	Equivalent f_{eg}
Global load case			
Wave impact	0,67	0,67	0,70
Floating	0,67	0,67	0,70
Slinging and jacking	0,50	0,50	0,53
Parking	0,50	0,50	0,53

Contents

Section 1
General requirements for machinery

1.1 General

1.1.1 The requirements of SSC Rules *Pt 9, Ch 1 General Requirements for Machinery* are applicable except where modified by the following Sections.

1.1.2 Items which have a limited service life, including rolling element bearings, drive belts and flexible hoses are to be maintained and replaced at intervals not exceeding that specified by the Original Equipment Manufacturer's recommendations. The service life of such components used in the ACV main propulsion system(s) is to be specified in the maintenance manual, which is to be submitted for information.

1.1.3 Where items of machinery are manufactured at a works that have a quality management system that has been recognised and accepted by LR as meeting the requirements of the Quality Assurance Scheme for Machinery, direct survey of individual items may not be required. *See* Rules for Ships, *Pt 5, Ch 1, 6 Quality Assurance Scheme for Machinery*.

1.1.4 Designs deviating from the requirements of the Rules for machinery will be subject to special consideration. It is to be demonstrated that the safety of the design is at least equivalent to that intended by the Rules. The submission is to be supported by an engineering and safety justification covering each deviation from the Rules, *see Ch 4, 1.1 General 1.1.5*.

1.1.5 An engineering and safety justification is to include:

(a) A technical argument to demonstrate how the safety of the systems has been realised
(b) A confidence argument to demonstrate how equivalence with the Rule requirements is to be satisfied
(c) A compliance argument to demonstrate how the design is going to be validated to prove equivalence with the Rule requirements.

The engineering and safety justification may include reference to relevant national or international standards and may require risk assessment in accordance with IEC/ISO 31010:2010 - *Risk management - Risk assessment techniques.*

Section 2
Plans and particulars

2.1 Plans and particulars to be submitted

2.1.1 The following data, plans and supporting information are to be submitted for appraisal at an early stage. Modifications to previously approved data or plans are also to be submitted for approval.

2.1.2 **Main engines:**

(a) Particulars including number, make, type and manufacturer's duty cycle, together with details of limited operational parameters.
(b) Estimated or proved service life of the engine between complete overhauls, and the replacement life of its major components.
(c) Type and flashpoint of fuel used.
(d) Particulars of engine maker's designated duty cycle and accumulated service history.
(e) Particulars of safety precautions against failure of high energy rotating parts in service, including results of any tests to destruction if available.
(f) Particulars of engine control/management system, including engine protection devices and controls.
(g) Particulars of ancillary equipment driven by the main engine essential to the operation of the ACV in service.
(h) A copy of the Engine Operations and Maintenance Manual(s).
(i) General arrangement plan of main engine.
(j) Details, dimensions and materials of the principal rotating parts for the engine family.
(k) Details of engine mounting arrangements.
(l) Arrangements and details of engine starting and control equipment.
(m) Engine test procedure.

2.1.3 **Transmission:**

(a) Manufacturer's calculations for the transmission system between main engines, propellers, and lift fans, including shafting, gearing, drive belts and clutches.
(b) A vibration analysis of the complete transmission system, including torsional, axial and sources of excitation, where applicable, supported by experimental results where necessary.
(c) General arrangement and detailed plans showing materials and dimensions of all main propulsion and lift shaft components.

2.1.4 **Propellers (airscrew) and lift fans:**

Arrangement and detailed plans, including particulars of materials, of propellers and lift fan assemblies. Details of service intervals, maintenance requirements and authorised maintainers. The following plans/documentation are to be submitted:

(a) The methods and procedures for construction, testing and balancing of propellers and lift fans.
(b) Propeller pitch control system schematic.
(c) The manufacturer is to issue a Certificate for Air Propellers for each propeller stating the agreed National Standard to which the propeller was designed, manufactured and tested. Documentation is to be provided that verifies the propeller performance in accordance with the agreed Standard.

2.1.5 **Piping Systems:**

Schematic layout or other equivalent documents for the following systems, together with a general description of each system, indicating operating pressures, etc. safety devices and means of protection against corrosion and contamination:

(a) Fuel System.
(b) Lubricating oil System.
(c) Hydraulic and/or pneumatic system(s) for steering trimming and air propeller pitch control.
(d) Air filtering to power units.
(e) Storage and transfer arrangements for water ballast systems.
(f) Bilge/dewatering arrangements.

2.1.6 **Drive Belts:**

Details of drive belts, including manufacturer's rating, are to be submitted together with design calculations showing design loading of the belts at maximum shaft torque.

2.1.7 **Steering Systems:**

Full details of the primary and secondary means of steering the ACV are to be submitted. The submission is to include following:

(a) A systematic arrangement drawing showing the arrangement(s) for the control of the air rudders and/or other means of steering the ACV, including skirt shift.
(b) Design calculations for the steering system, showing maximum mechanical loadings of the linkages, fastenings and power units, including securing arrangements.

(c) Where additional thrusters (e.g. bow thrusters) are used for essential steering purposes, full details are to be submitted.

2.1.8 **Test Programme:**

LR will review the manufacturer's proposed test programme and results to confirm that all criteria and technical requirements as recorded in the design appraisal have been addressed.

■ *Section 3* Prime movers

3.1 General requirements

3.1.1 The requirements of SSC Rules *Pt 10 Prime Movers* apply.

3.1.2 The use of engines that have not been approved by LR for main propulsion or lift fans in accordance with the requirements of *Ch 4, 3.1 General requirements 3.1.1* may be specially considered provided that all of the following conditions are met:

(a) A proven service history relevant to the intended service conditions and the intended application with similar duty rating can be provided;
(b) The design, construction, testing, installation, operation and prescribed maintenance are appropriate for its intended service conditions and application;
(c) All external high-pressure fuel lines are jacketed. High pressure fuel piping on common rail fuel systems shall be specially considered; and
(d) Evidence that the manufacturer supports its use in the intended application can be provided.

It should be noted that the use of such machinery may limit the possible machinery Class notations applicable to the ACV, *see* SSC Rules *Pt 1, Ch 2, 3.9 Class notations (machinery) 3.9.1*.

■ *Section 4* Transmission systems

4.1 General requirements

4.1.1 The requirements of SSC Rules, *Pt 11, Ch 2, 1 General requirements* apply, except where modified by this Section.

4.1.2 Shafts transmitting torque to propulsion and lift fans are to be suitably supported. Drive belt pulley shafts are to be sufficiently sized and supported to absorb lateral bending forces and minimise deflection of the shaft at all operating loads and speeds.

4.1.3 Suitable measures are to be provided to isolate the engine crankshaft from lateral forces arising from the transmission arrangement.

4.1.4 Suitable means are to be provided to absorb axial thrust forces from lift fans and air propellers.

4.1.5 Rolling element bearings are to be sealed against the ingress of water and airborne contaminants.

4.1.6 Where drive belts are used for power transmission the following requirements are applicable:

(a) belts with positive traction are to be used;
(b) belt tensioning devices are to be provided with suitable securing and locking arrangements;
(c) belt alignment is to be within the belt manufacturer's design tolerance.

4.1.7 Drive arrangements for propellers and lift fans, outside of the enclosed machinery space, are to be protected from foreign objects and airborne sand/grit.

4.1.8 Guards are to be installed around all exposed drive arrangements.

Section 5
Air propellers and lift fans

5.1 General requirements

5.1.1 This Section is to be read in conjunction with the General Requirements for Machinery in SSC Rules*Pt 9, Ch 1 General Requirements for Machinery*.

5.1.2 The propeller or lift fan when suitably mounted and operated in accordance with the declared rating and operational limitations as required by CS-P 50, shall be of sufficient strength and stiffness to withstand the most adverse combination of loads which can arise during its use without exceeding acceptable stress levels. LR is to be notified of any limiting conditions associated with such equipment, e.g. icing limits.

5.1.3 Except for the requirements of 5.2, propellers are to be designed, constructed and tested in accordance with the requirements of *European Aviation Safety Agency (EASA) Certification Specifications for Propellers CS-P*. Other industry equivalent standards may be accepted in agreement with LR.

5.1.4 Lift fans are generally to be designed, constructed and tested in accordance with the requirements of *European Aviation Safety Agency (EASA) Certification Specifications for Propellers (CS-P)* as applicable. Other industry equivalent standards may be accepted in agreement with LR.

5.1.5 Organisation(s) responsible for design, construction and testing of propellers and lift fans are to be certified in accordance with EASA Part 21. Design Organisations and Production Organisations are to hold Design Organisation Approval and Production Organisation Approval respectively. It is to be demonstrated to LR that the required working practices are being applied throughout the organisation.

5.1.6 Air propellers and lift fans are to be installed and balanced in accordance with the EASA Part 21 'approved' manufacturer's requirements, taking into account the Instructions for Propeller Installation and Operation required by CS-P 30.

5.1.7 Air propellers are to be inspected and maintained in accordance with approved Manuals required by CS-P 40, Service Management Plan required by CS-P 160 and Service Bulletins produced by the EASA Part 21 'approved' manufacturer. Any organisation and personnel involved in maintenance is to be certified and act in accordance with the requirements of EASA Part 145. The maintenance organisation is to be also licensed by the propeller manufacturer for the propeller 'type'.

5.1.8 Propellers and lift fans are to be capable of functioning satisfactorily without unacceptable damage when operated in the likely prevailing conditions of icing, spray, sand, aggregate, salt etc. Due regard shall be paid to effects of corrosion, electrolytic action between different metals, erosion or cavitation which may result from operation in the environments to which they are subjected. Materials particularly susceptible to the marine environment are to be avoided.

5.1.9 Materials for propellers and lift fans which comply with National or proprietary specifications may be accepted in lieu of those required by the Rules for Materials provided that they are approved by LR for the specific application.

5.1.10 Where aerospace grade aluminium alloy materials are proposed, specific consideration shall be given to their protection from corrosion in the marine environments in which they are intended to operate.

5.1.11 A compliance matrix detailing how the requirements for propellers and lift fans are to be verified is to be agreed with LR prior to production of propellers and lift fans. Any documentation referenced within the matrix which provides evidence of compliance is to be made available to LR on request.

5.1.12 A record of all work carried out on the air propeller is to be maintained. The record is to include details and authorisation of the persons carrying out this work. The scope of work permitted for on-board maintenance is to be defined by the Part 21 approved manufacturer.

5.1.13 Non-destructive examination of propeller and lift fan equipment is to be carried out by organisations and personnel approved in accordance with EN 4179:2009, *Aerospace series. Qualification and approval of personnel for non-destructive testing*, or a recognised equivalent 'standard' acceptable to LR.

5.1.14 For multi-propeller ACVs, with one air propeller or lift fan out of action, the ACV is to be capable of maintaining steerage. Propulsion systems comprising single essential components will be specially considered.

5.1.15 The failure of one air propeller or lift fan, or its control system, shall not render any other air propeller or lift fan inoperative.

5.2 Endurance testing

5.2.1 Endurance tests on the Propeller System type must be made on a representative engine and in accordance with *Ch 4, 5.2 Endurance testing 5.2.2* or *Ch 4, 5.2 Endurance testing 5.2.3*, as applicable, without evidence of failure or malfunction. An analysis based on tests of Propellers of similar design may be used in place of the tests of *Ch 4, 5.2 Endurance testing 5.2.2* and *Ch 4, 5.2 Endurance testing 5.2.3*.

5.2.2 Fixed Pitch Propellers and Adjustable Pitch Propellers must be subjected to one of the following tests:

(a) A 50-hour test where the Propeller must be operated at maximum power and rotational speed during at least five hours of this test, and at not less than 90 percent of the maximum power and rotational speed for the remainder of the 50 hours.

(b) A 50-hour test where the Propeller must be operated at maximum continuous power and rotational speed.

5.2.3 Variable Pitch Propellers must be subjected to the following tests:

(a) A 110-hour endurance test which must include the following conditions:

(i) 5 hours at maximum continuous power and rotational speed, and thirty 10-minute cycles composed of:

- Acceleration from idle,
- 5 minutes at maximum power and rotational speed,
- Deceleration, and
- 5 minutes at idle

(ii) 50 hours at maximum continuous power and rotational speed

(iii) 50 hours, consisting of ten 5-hour cycles composed of:

- 5 accelerations and decelerations between idle and maximum power and rotational speed,
- 4,5 hours at approximately even incremental conditions from idle up to, but not including maximum continuous power and rotational speed, and
- 30 minutes at idle.

Section 6
Shaft vibration and alignment

6.1 General requirements

6.1.1 The requirements of SSC Rules *Pt 13 Shaft Vibration and Alignment* are applicable where appropriate.

Section 7
Steering systems

7.1 General requirements

7.1.1 The requirements of SSC Rules *Pt 14, Ch 1 Steering Systems* apply, except where modified by this Section.

7.1.2 Directional control of the ACV is to be maintained in the event of a single failure within the primary directional control system.

7.1.3 As an alternative, independent means of steering the ACV are to be provided in the event of a failure of the primary system. The effectiveness of the alternative system is to be demonstrated during trials.

7.1.4 Where air rudders are used for steering the ACV, the design is to be such that no secondary damage is to be caused and the control of the ACV is to be maintained in the event of loss of the actuating system, or mechanical failure of the linkages.

Section 8
Piping systems

8.1 General requirements

8.1.1 The requirements of SSC Rules, *Pt 15, Ch 1 Piping Design Requirements*, and *Pt 15, Ch 3 Machinery Piping Systems* are to be applied, except where modified by this Section.

8.1.2 All piping systems and their associated fittings which are subject to internal pressure are appropriately tested, including a pressure test, before being put into service for the first time.

8.1.3 Fuel piping is to be routed outside accommodation and cargo spaces. Within engine spaces all piping and equipment carrying flammable fluids is to be manufactured with non-heat sensitive materials.

8.1.4 Where the surface temperature of engine exhaust pipes and silencer may exceed 220°C, they are to be water cooled or efficiently lagged to minimise the risk of fire and to prevent damage by heat. Where lagging covering the exhaust piping system including flanges is oil-absorbing or may permit penetration of oil, the lagging is to be encased in sheet metal or equivalent. In locations where the Surveyor is satisfied that oil impingement could not occur, the lagging need not be encased.

8.1.5 Materials used in piping systems are to be compatible with the fuel conveyed and due regard given to the risk of fire. Non-metallic piping material may be permitted in certain systems, provided the integrity of the hull and watertight decks and bulkheads is maintained.

8.1.6 For ACVs with no sea-water connections, where it can be demonstrated that the buoyancy of the ACV in the damage stability condition can be achieved without the need for dewatering, a bilge system complying with the requirements of *Pt 15, Ch 2, 4 Bilge pumping and drainage systems* of the SSC Rules need not be fitted.

8.1.7 A bilge system for drainage in the case of flooding may not be required where the ACV in still water has sufficient buoyancy and positive stability simultaneously to ensure that:

(a) after flooding has ceased and a state of equilibrium has been reached, the final waterline is below the level of any opening through which further flooding could take place by at least 25 per cent of the significant wave height corresponding to the worst intended conditions;
(b) there is a positive freeboard from the damage waterline to survival craft embarkation positions;
(c) essential emergency equipment, emergency radios, power supplies and public address systems needed for organising the evacuation remain accessible and operational; and
(d) the residual stability of the ACV meets the appropriate criteria as laid out in HSC 2000 Code, annexes 7 and 8 according to Table 2.3.4. Within the range of positive stability governed by the criteria of annexes 7 and 8, no unprotected opening is to be submerged.

Section 9
Electrical and Control Engineering

9.1 General requirements

9.1.1 Electrotechnical systems are to be designed and approved in accordance with the requirements of the Control and Electrical Engineering Sections of *Pt 16 Control and Electrical Engineering* of the SSC Rules.

9.1.2 The engines are to be fitted with adequate safety monitoring and control devices in respect of speed, temperature, pressure and other operational functions and are to be agreed with LR.

9.1.3 The machinery and engineering systems installation is to be suitable for operation from a centralised control station in accordance with the requirements of the CCS notation, *see* SSC Rules, *Pt 16, Ch 1, 5 Machinery operated from a centralised control station - CCS notation*. This includes automatic fire detection system, bilge alarm system, remote machinery instrumentation and alarm systems.

9.1.4 Where the primary engine shutdown controls are mounted within engine spaces, engine shutdown capability must be retained during flame tests for a period of five minutes.

9.1.5 Independent means are to be provided for shutting off the fuel supply outside the fire retardant bulkheads of the engine spaces (*see* ISO 15540 and 15541, as applicable).

Contents

Section 1
Fire safety and appliances

1.1 Introduction

1.1.1 For fire and safety aspects, ACVs are categorised as follows:

- Light ACV where less than or equal to 1000 kg and up to and including 12 persons;
- Small ACV where greater than 1000 kg and up to and including 12 persons and less than 24 m in length;
- Large ACV where greater than 12 passengers or greater than or equal to 24 m in length.

where length is as defined in *Ch 1, 1.2 Definitions and symbols*.

1.1.2 For the Large ACV category, refer to the High Speed Craft Code (2000) 2008.

1.2 Light and Small ACVs where the total installed power is less than 750kW

1.2.1 In general Light ACVs are fitted with air cooled engines which are difficult to enclose fully in airtight boxes, therefore a minimum of two multi-purpose portable fire-extinguishers should be provided as the fire-extinguishing medium.

1.2.2 At least one portable fire-extinguisher is to be located so that it can easily be reached from the main steering position of the ACV and the other within close proximity of the machinery space.

1.2.3 ACVs should be fitted with fire-extinguishers to a recognised Standard, each with minimum fire rating of 13A/113B, or smaller extinguishers giving the equivalent fire rating.

1.3 Small ACVs where the total installed power exceeds 750kW

1.3.1 On Small ACVs and as far as reasonably practicable the boundary or enclosure box of the machinery space should, with special consideration given to fire flaps, be arranged to contain the fire-extinguishing medium, i.e. the machinery space should be capable of being closed down in order that the fire-extinguishing medium cannot escape. Any fans located within, or feeding a machinery space, should be capable of being stopped from outside the space in the event of a fire.

1.3.2 Fire-extinguishing, suitable for the capacity of the engine space, should be provided. A person should not be required to enter the machinery space in order to extinguish a fire.

1.3.3 Combustible materials and liquids should not be stowed in the machinery space. If non-combustible materials are stowed in the engine space, they should be adequately secured against falling on machinery, and cause no obstruction to access to or from the space.

1.3.4 For Fibre Reinforced Plastic (FRP) Construction, machinery space boundaries should prevent the passage of smoke and flame for 30 minutes, and be fitted with materials of an approved type. Fire tests should be conducted in accordance with Annex 1, Pt 11 of the FTP Code.

1.3.5 For Aluminium and Wood Construction, machinery space boundaries should have an equivalent level of fire protection as per *Ch 5, 1.3 Small ACVs where the total installed power exceeds 750kW 1.3.4*.

1.4 Insulation

1.4.1 Thermal or acoustic insulation fitted inside the machinery space should be of a non-combustible material.

1.4.2 The thermal or acoustic insulation will be considered as being a non-combustible material in accordance with the FTP Code Annex 1, Part1.

1.4.3 Insulation should be protected against impregnation by flammable vapours and liquids. Where insulation is cut, the edges should be protected against such impregnation, e.g. by the use of non-combustible tape. Where the insulation is vulnerable to damage, it should be protected.

1.5 Fire detection

1.5.1 Fire detection should be fitted in accordance with FSS Code, Chapter 9.

1.5.2 The fire detectors should be appropriate to the hazard identified and should give an audible warning that can be heard in the space concerned, and in the control position, when the ACV is in operation.

1.6 Fire-extinguishing for ACVs with enclosed interior spaces

1.6.1 Enclosed interior spaces are to be provided with a sufficient number of portable fire-extinguishers to ensure that at least one extinguisher will be readily available for use in every compartment.

1.6.2 Portable fire-extinguishers should be stowed in readily accessible positions.

1.6.3 Portable fire-extinguishers intended for use in the space are to be stowed near the entrance to that space. At least one portable fire-extinguisher is to be located within reach of the main steering position of the ACV.

1.6.4 Where cooking facilities are provided a portable fire-extinguisher of a type appropriate to the energy source used is to be located in a position readily accessible for use in the event of a fire.

1.6.5 Where a risk of fire is identified in a cooking area one fire blanket of a recognised Standard is to be provided within close proximity to the area.

1.7 Fire-extinguisher capacities for ACVs with enclosed interior spaces

1.7.1 ACVs should be fitted with a minimum of two multi-purpose portable fire-extinguishers to a recognised Standard, each with minimum fire rating of 13A/113B, or smaller extinguishers giving the equivalent fire rating.

1.8 Furnishing materials for ACVs with enclosed interior spaces

1.8.1 Upholstery composites (fabric in association with any backing or padding material) used throughout the ACV including open decks should be approved in accordance with the IMO FTP Code, Annex 1, Part 8, or equivalent.

1.8.2 Organic foams used in upholstered furniture and mattresses should be of the combustion modified type.

1.8.3 Suspended textile materials such as curtains or drapes should be approved in accordance with the IMO FTP Code, Annex 1, Part 7, or equivalent.

■ *Section 2* Stability

2.1 General

2.1.1 Stability of the ACV is to be in compliance with the applicable requirements of the *HSC 2000 Code - International Code of Safety for High-Speed Craft, 2000 – Resolution MSC.97(73)* in the absence of any alternative criteria specified by the Flag Administration.

■ *Section 3* Life-saving appliances

3.1 General requirements

3.1.1 Life-saving appliances should be provided in accordance with *Table 5.3.1 Life-saving appliances*.

Table 5.3.1 Life-saving appliances

Craft category		Light	Small
Liferafts	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.1*)	Yes	Yes
Recovery of persons from the sea	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.2*)	Yes	Yes
Lifejackets	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.3*)	Yes	Yes
Immersion suits	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.4*)	Yes	Yes
Lifebuoys (total)		2	4
Lifebuoys with light and smoke	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.5*)	1	2
Lifebuoys with buoyant lifeline	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.5.(b)*)	1	2
Set of line throwing appliances		1	1
(4 lines plus 4 charges)			
Rocket parachute flares		6	6
EPIRB	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.6*)	1	1
SART	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.7*)	1	1
General Alarm (Greater than 750kW)	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.8*)	Yes	Yes
Emergency Lighting	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.9*)	No	Yes
Posters and signs showing survival craft and equipment operating instructions		Yes	Yes
Training manual		Yes	Yes
Instructions for onboard maintenance		Yes	Yes
Life-saving signals and rescue poster – SOLAS No 1 in wheelhouse	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.10*)	Yes	Yes
Portable VHF	(*see Ch 5, 3.2 Equipment carriage requirements 3.2.11*)	1	2
Hand flares		6	6
Smoke signals		2 Buoyant + 2 Hand held	2 Buoyant + 2 Hand held

3.1.2 All equipment fitted should be of a type which has been accepted by the Administration as complying with IMO Lifesaving Appliances Code and IMO Resolution MSC.81(70).

3.1.3 Additional life-saving equipment which is provided should meet the requirements of *Ch 5, 3.1 General requirements 3.1.2*.

3.1.4 All life-saving equipment carried should be fitted with retro-reflective material in accordance with the recommendations of IMO Resolution A.658(16) as amended.

3.1.5 Liferaft embarkation arrangements should comply with the following:

- Where the distance between the embarkation deck and the top of the liferaft buoyancy tube exceeds 1 metre with the ACV in its lightest condition, an embarkation ladder is to be provided. A means for fastening is to be provided and ladders are to be readily available for use at all times.

3.1.6 Inflatable lifejackets, inflatable liferafts and hydrostatic release units other than a disposable hydrostatic release unit should be serviced, at intervals not exceeding 12 months unless extended service intervals have been approved by the Administration; at a manufacturers approved service station.

3.1.7 Maintenance of equipment should be carried out in accordance with the instructions for onboard maintenance.

3.1.8 The stowage and installation of all life-saving appliances is to be to the satisfaction of the Administration.

3.1.9 All life-saving appliances should be in working order and be ready for immediate use at the commencement of, and at all times during, the voyage.

3.2 Equipment carriage requirements

3.2.1 Liferafts:

(a) The liferafts carried must contain the necessary 'emergency pack'. For ACVs operating within 60 miles from a safe haven, liferafts provided may be equipped with a 'SOLAS B PACK'.

(b) Light ACVs are permitted to use Valise type rafts if they can be stored in a protected area and are made ready for use when under way.

(c) For Small ACV category the liferafts are to be stowed in glass reinforced plastic GRP containers and provision should be made for a 100 per cent capacity on either side of the ACV.

(d) GRP containers containing liferafts should be stowed on the weather deck or in an open space and fitted with hydrostatic release units so that the liferafts will float free of the ACV and automatically inflate.

(e) Liferaft approval includes approval of their stowage, launching and float-free arrangements.

(f) For ACVs operating with reduced personnel aboard, attention is drawn to the dangers associated with the use of large capacity liferafts with small numbers of persons embarked.

(g) ACVs expected to operate in soft sand and mud shall have mud escape equipment to allow all persons to walk over soft mud without becoming trapped.

3.2.2 Recovery of persons from the sea:

(a) Means should be provided for the recovery of a person from the sea to the ACV and it should be assumed that the person is unconscious or unable to assist in the rescue.

(b) The ACV should have sufficient mobility and manoeuvrability in a seaway to enable persons to be retrieved from the water. For assessing this ability it is not considered acceptable to retrieve persons over the stern of the ACV. The recovery location should be visible from the conning position at all times during the recovery, although this may be achieved by the use of remote controls where necessary.

(c) The ACV should be provided with suitable equipment and/or arrangements to enable the person(s) to be recovered without further persons entering the water.

3.2.3 Lifejackets:

(a) One adult SOLAS approved lifejacket should be provided for each person on board; in addition spare adult lifejackets sufficient for at least 10 per cent of the total number of persons on board or two adult SOLAS approved lifejackets for each person, whichever is the greater, should be provided. Each lifejacket should be fitted with a light and whistle.

(b) If the adult lifejackets provided are not designed to fit persons weighing up to 140 kg and with a chest girth of up to 1,750 mm, a sufficient number of suitable accessories may be required to provide a lifejacket for each such person on board to allow them to be secured to such persons.

(c) Included in the above-mentioned number of lifejackets, there should be at least two SOLAS approved inflatable lifejackets for the use of the crew on any rescue boat or inflatable boat carried on board.

(d) One SOLAS approved child lifejacket or infant lifejacket should be provided for each child or infant on board.

3.2.4 Immersion suits:

(a) One approved immersion suit should be provided for each person on board; these may be of the non-insulated type.

(b) Due consideration should be given to the provision of appropriate immersion/ thermal protection for children and infants carried on board.

(c) For cold water areas of operation, the insulated type should be carried on board. Reference to Resolution IMO MSC Circular 1046 should be made for assessment of thermal protection.

Due consideration will be given to the provision of immersion suits depending on the area of operation.

3.2.5 Life-buoys:

(a) Lifebuoys with combined self-igniting light and self-activating smoke signals are to be provided port and starboard and should be capable of quick deployment from the navigating bridge.

(b) The attached buoyant lifeline required on each of two of the lifebuoys is to have a minimum length of 30 metres.

(c) Each lifebuoy should be marked with the ACV's name and Port of Registry.

3.2.6 Emergency Position Indicating Radio Beacon (EPIRB):

An approved EPIRB should be installed in an easily accessible position ready to be manually released, capable of being placed in a survival craft and floating free if the ACV sinks. All EPIRBs should be registered with the Administration. EPIRBs are to be tested annually and serviced at not more than five yearly intervals by an approved shore-based maintainer.

3.2.7 Search and Rescue Radar Transponders (SART):

The SART is to be stowed in an easily accessible position so that it can rapidly be placed in any survival craft. Means should be provided in order that it can be mounted in the survival craft at a height of at least 1 metre above sea level.

3.2.8 General alarm:

For ACV machinery installations greater than 750kW a general alarm shall be provided. This alarm may consist of the ship's whistle or siren providing it can be heard in all parts of the ACV.

3.2.9 Emergency Lighting:

(a) Alleyways, internal and external stairways, and exits giving access to, and including, the muster and embarkation stations should be adequately lit.

(b) Adequate lighting is to be provided in the vicinity of the survival craft, launching appliance(s) (when provided) and the over side area of sea in way of the launching position(s).

3.2.10 Life-saving signals and rescue poster:

When display space in the wheelhouse is restricted, the two sides of a SOLAS No2 poster (as contained in liferaft equipment packs) may be displayed in lieu of a SOLAS No 1 poster.

3.2.11 Portable VHF Radio:

Each ACV should carry a portable Very High Frequency (VHF) radio fitted with a Digital Selective Calling (DSC) facility, and charging facilities for the radio battery or batteries, or a spare battery or batteries. Arrangements should be made to protect the portable VHF and spare battery or batteries from water damage, e.g. waterproof cover.

Published by Lloyd's Register Group Limited
Registered office (Reg. no. 08126909)
71 Fenchurch Street, London, EC3M 4BS
United Kingdom